Development and Demonstration of Advanced Tooling Alloys for Molds and Dies

Benefits

Die life may be increased by 20%. In addition, there may be a 25% reduction in energy consumption associated with the manufacture and heat treatment of dies.

Applications

There are numerous applications in the IOF industries:

- **Glass:** Improved hot glass contact materials; e.g., molds and rolls.
- **Metalcasting:** Development of die materials to eliminate solder and heat checks in permanent castings.
- **Steel:** Materials and manufacturing methods for die materials and sheet-forming die development. Development of additional methods for materials and manufacturing, especially for short-run tooling.

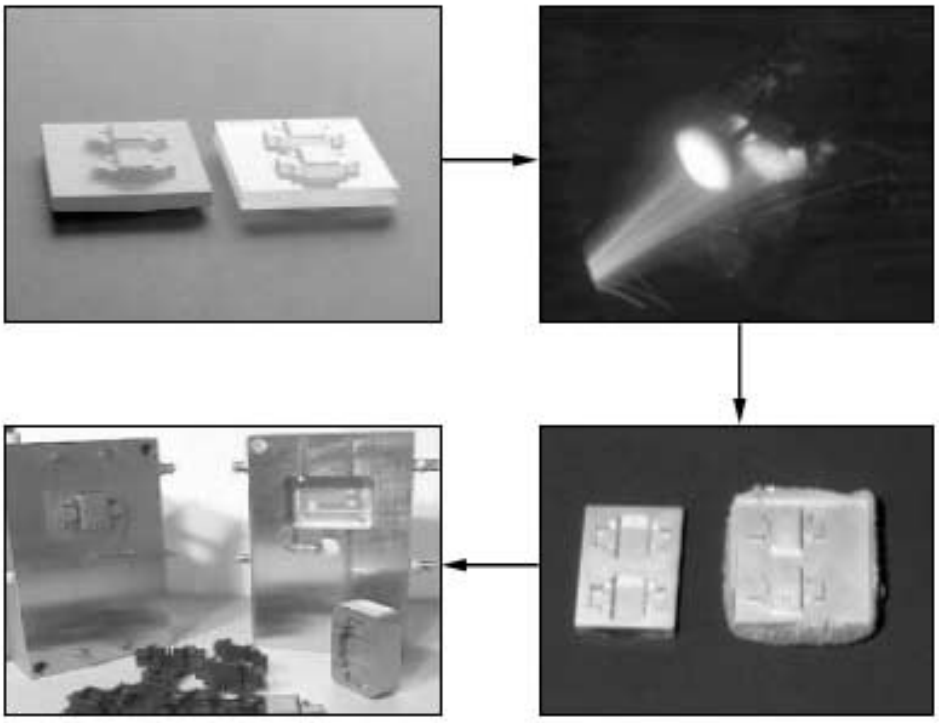
Additional applications also exist in the supporting industries:

- **Forging Industry:** Advanced die materials.
  Heat Treating: Materials of construction in furnaces.

A new class of mold and die tool steels will be developed to enable production of dies by spray forming

This project will develop and demonstrate a new class of mold and die tool steels tailored for rapid solidification processing (RSP), including spray forming. Improvements in high-temperature strength, wear resistance, toughness, thermal-fatigue resistance, and other properties over conventional tool steels will be demonstrated. Production runs will be conducted by industry to demonstrate that the new die materials exhibit a service life that exceeds the life of conventional die materials.

This project seeks to contribute to DOE's Industries of the Future (IOF) program by improving manufacturing productivity while reducing energy consumption and scrap during the manufacture of molds and dies. The IOF industries and supporting industries most closely benefiting from this research are glass, metalcasting, steel, forging and heat-treating.



RSP Tooling™ processing steps

Project Description

Goal: The goal of the project is to research, develop, and demonstrate a new class of tooling alloys that improve productivity, increase die life, and at the same time, reduce the energy consumed during the production of dies used in glass component manufacture, forging, die casting, and stamping. The objectives of this effort include
– Increasing die life by a minimum of 20% and
– Reducing energy consumption associated with the manufacture and heat treatment of dies by a minimum of 25%.

Issues: There are no commercially available tooling technologies (other than the conventional machining approach) that satisfy the needs of production tooling for the forging, die-casting, and stamping industries. In each case, production tools are machined from a block of forged tool steel, followed by grinding, polishing, and heat-treatment unit operations. In the development of the new class of ferritic tool steels by rapid solidification, the following issues will need to be addressed:
– Successful implementation of bench-scale systems and
– Optimization of heat treatments, leading to improvements in thermal fatigue resistance, hardness, toughness, strength, and other properties.

Approach: The project includes the following tasks:
– Implement modifications to an existing bench-scale RSP tooling system;
– Spray-deposit, section, and analyze blocks of tool steels to benchmark material properties (alloys designated by industry).
– Develop an understanding of the interplay of the characteristics of the spray plume (droplet thermophysical properties, size distribution, velocity, heat content, flux, and spray pattern) with those of the tool pattern during tool formation; and
– Develop an understanding of residual stress development in spray-formed steel and investigate process parameters and thermal history that will minimize this phenomenon.

Potential payoff: A 20% increase in die life may be experienced by various IOF industries. Also, there would be a 25% reduction in energy consumption associated with manufacturing and heat-treating dies.

Progress and Milestones

- Establish microstructure/property relationship and study microstructure transformation of spray-formed tool steels during low-temperature heat treatments, particularly carbide precipitation and growth.
- Assess structure and properties of modified tool steel alloys.
- Evaluate the effect of alloy additions on carbide stability, size, and distribution before and after heat treatment.
- Using modified tooling alloys, produce spray-formed tooling inserts and send to industry participants for analysis and in-service evaluation, including lifetime studies and evaluation of failure modes.
- Complete sample die preparation and in-service evaluation of dies.

Primary

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Project partners

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